

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.



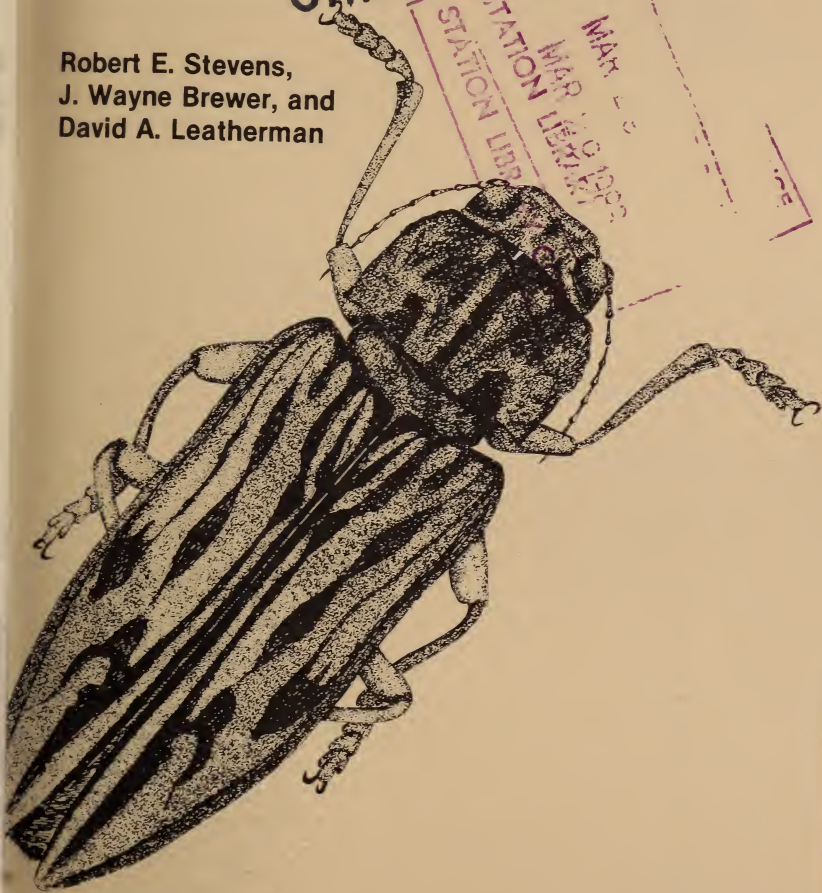
x1
525
94
AP

**Insects Associated
with Ponderosa Pine in the
Rocky Mountains and the
Southwest**

PSW

Office of Information

Robert E. Stevens,
J. Wayne Brewer, and
David A. Leatherman



General Technical Report RM-94
Rocky Mountain Forest and
Range Experiment Station
Forest Service
U.S. Department of Agriculture

Abstract

Ponderosa pine serves as a host for a wide variety of insects. Many of these, including all the particularly destructive ones in the area, are discussed in this booklet. Included are a key to the major insect groups, an annotated list of the major groups, a glossary, and a list of references. This report supersedes USDA Forest Service General Technical Report RM-75.

Insects Associated with Ponderosa Pine in the Rocky Mountains and the Southwest

Robert E. Stevens¹, J. Wayne Brewer², and David A. Leatherman³

¹*Entomologist, Rocky Mountain Forest and Range Experiment Station. Station's headquarters is in Fort Collins, in cooperation with Colorado State University.*

²*Professor, Department of Zoology and Entomology, Colorado State University, Fort Collins.*

³*Entomologist, Colorado State Forest Service, Colorado State University, Fort Collins.*

Contents

	Page
Introduction	1
Section 1—Common Groups of Insects Associated with Ponderosa Pine	3
Section 2—Key to Insect-Caused Tree Damage	4
Index	4
Damage to Cones	4
Damage to Shoots, Twigs, or Terminals	4
Damage to Foliage (Needles) Only	5
Damage to Trunk, Entire Tree, or Wood	6
Section 3—Annotated List of Common Insect Species and Groups Associated with Ponderosa Pine	7
Grasshoppers, Crickets, and Others—Order Orthoptera .	7
Termites—Order Isoptera	7
Earwigs—Order Dermaptera	7
True Bugs—Order Hemiptera	7
Aphids, Scales, and Others—Order Homoptera	9
Lacewings and Snakeflies—Order Neuroptera	12
Beetles and Weevils—Order Coleoptera	13
Moths and Butterflies—Order Lepidoptera	29
Flies and Midges—Order Diptera	35
Ants, Bees, Sawflies, and Allies—Order Hymenoptera ..	37
Section 4—References	40
Section 5—Glossary	42

Insects Associated with Ponderosa Pine in the Rocky Mountains and the Southwest

Robert E. Stevens, J. Wayne Brewer, and David A. Leatherman

INTRODUCTION

This booklet is about the insects associated with ponderosa pine, a major component of forests throughout the West. Its focus is the central Rocky Mountain area, including portions of Wyoming, Colorado, and South Dakota, as well as Arizona and New Mexico. It replaces USDA Forest Service General Technical Report RM-75, "Insects Associated with Ponderosa Pine in Colorado."

While many hundreds of kinds of insects can be found in the ponderosa pine forest, we are mainly interested in those that have close ecological ties with the pines—those that live in and on the trees themselves. Many of these insects are injurious to the trees and are thus particularly important to the landowner and the land manager.

Organization.—The booklet is divided into five sections:

1. A table listing groups of insects commonly seen in the ponderosa pine forest.
2. A key to insect-caused tree damage.
3. An annotated list of the groups and species referred to in sections 1 and 2.
4. A list of references, or sources of additional information.
5. A glossary of specialized terms.

We have kept the text as brief as possible. Readers who need help in identifying insects or recommendations on insect control should consult with specialists associated with federal, state, and local government forestry organizations. Consultation on control methods is particularly desirable, as recommended procedures are frequently updated.

References.—There is abundant literature on the various insect groups. The book by Furniss and Carolin (1977)⁴ is currently the best single reference on western forest insects and contains detailed discussions of most insect species dealt with here. Essig (1958) and Borror et al. (1981) are also good sources of general entomological information; Borror and White (1970) is a good field guide to the major groups of insects.

⁴*This and similar citations refer to items in Section 4—References.*

Insect Names.—Insects all have scientific names, and the more important species also have common names. The common names are used where possible in this booklet, but where there is none, we are obliged to use the scientific name only. The following three paragraphs describe the system of scientific names and are included to help the reader better understand it.

Insects are generally categorized into 26 major groups, or orders. Only 10 of these orders are commonly seen in the ponderosa pine forest (section 1). Orders are further subdivided into families, genera (singular genus), and species (singular also species). Family names always end in “-idae.” Genus and species names are always italicized in print or underlined when handwritten or typed.

The genus and species, along with the author (the scientist who named the insect species), make up the scientific name. For example, the scientific name for the mountain pine beetle is *Dendroctonus ponderosae* Hopkins. Sometimes the author's name is shown in parentheses: *Dendroctonus rufipennis* (Kirby). This indicates that the species was originally placed in another genus. For brevity, genus names are commonly abbreviated after the first use; for example, *D. ponderosae* Hopkins. Oftentimes also the author's name is dropped after initial use.

In rare instances, an additional element is required in a scientific name to identify a subspecies. For example, the scientific name for the pine tortrix is *Choristoneura lambertiana ponderosana* Obraztsov.

Insect life stages.—All insects pass through a series of distinctive developmental stages. Most that we are concerned with pass through four life stages: egg, larva (grub, caterpillar, maggot, etc.), pupa or resting stage, and adult. Others have an abbreviated pattern of egg, nymph (resembles adult but lacks wings), and adult.

Use of this booklet.—Many readers will use this booklet to find out what kinds of insects are damaging their trees. The best way to do this, once the insects or damage have been found, is as follows:

1. Locate the proper part of the key (section 2) for symptoms
2. Use the key to tentatively identify the kind of insect.
3. Look up the insect in the annotated list (section 3).
4. If desired, look up extra reading material in the references section.

SECTION 1

COMMON GROUPS OF INSECTS ASSOCIATED WITH PONDEROSA PINE⁵

Common names	Order	Main habitats
Grasshoppers and others	Orthoptera	On ground and foliage
Termites	Isoptera ⁶	In decaying wood
Earwigs	Dermaptera ⁶	In litter, under bark
True bugs	Hemiptera	On foliage, cones
Aphids, scales, and Others	Homoptera	On foliage
Lacewings and snakeflies	Neuroptera ⁶	On foliage, branches
Beetles and weevils	Coleoptera	In or on foliage, cones or branches, in cambium area, or in wood
Moths and butterflies	Lepidoptera	Larvae in or on foliage, shoots, cones, or cambium area
Flies and midges	Diptera	Larvae in foliage, shoots, or cones
Ants, bees, sawflies, others	Hymenoptera	Larvae on foliage or wood; adults on or around trees

⁵*Groups of insects (e.g., dragonflies) found in the forest but not particularly associated with the trees are excluded.*

⁶*Orders that do not include species commonly destructive to living trees.*

SECTION 2

KEY TO INSECT-CAUSED TREE DAMAGE

Index

	Page
Damage to Cones	4
Damage to Shoots, Twigs, or Terminals	4
Damage to Foliage (Needles) Only	5
Damage to Trunk, Entire Tree, or Wood	6

Damage to Cones

1. Entire cones distorted and/or discolored; may be pitchy; interior portions mined or otherwise damaged	
..... cone moths, <i>Dioryctria</i> , etc.	31
..... cone beetles, <i>Conophthorus</i>	27
..... cone weevils, <i>Conotrachelus</i>	18
2. Cone scales and/or seeds stuck together; small maggots without distinctive head regions	cone midges 35
3. Seeds hollowed out or inside material shrunk; cones appear normal	seed chalcids 39
..... cone bug, <i>Leptoglossus</i>	8
4. Larvae and/or pupae in cone pith; larvae bore into seeds	seed moths, <i>Cydia</i> 32

Damage to Shoots, Twigs, or Terminals

1. Terminals only affected. No fading; needles more or less shortened, not distorted; pith mined out; terminal thickened; terminal may continue to live although superseded by lateral(s)	
..... shoot borer, <i>Eucosma</i>	32
2. Terminals and/or laterals affected	
a. Needles faded	
(1) Shoots partly mined out	
..... pitch midges, <i>Cecidomyia</i>	35
..... twig weevils, <i>Magdalis</i>	18
(2) Shoots completely mined out; wood destroyed ..	
..... tip moths, <i>Rhyacionia</i>	32
(3) Cambial area only mined out	twig beetles 27

	Page
(4) Masses of pitch produced externally on shoots ..	
..... twig borers, <i>Dioryctria</i>	31
..... pitch nodule moths, <i>Petrova</i>	32
b. No fading; needles badly swollen at bases	
..... needle midges	35
c. No fading; shoots covered with masses of fluffy	
white wax	9
..... woolly aphids, <i>Pineus</i>	

Damage to Foliage (Needles) Only

1. Foliage chewed, thin, or sparse	
a. Masses of silken webbing mixed with frass,	
associated with defoliation	
(1) Throughout crown; webbing relatively sparse ...	
..... budworms, <i>Choristoneura</i>	33
..... needle-sheath miner, <i>Zelleria</i>	35
(2) Throughout crown; webbing a dense, nearly	
spherical, frass-filled mass	
..... pine webworm, <i>Tetralopha</i>	31
(3) Mainly in tree tops; heavy silk webs	
..... tiger moths, <i>Halisidota</i>	29
b. Little or no webbing produced	
(1) Caterpillars, often clustering together	
..... sawflies	37
..... pine butterfly, <i>Neophasia</i>	29
..... pandora moth, <i>Coloradia</i>	29
(2) Not caterpillars; insects often not seen; "bites"	
taken out of needles	7
..... grasshoppers	
..... weevils	16
2. Needles faded; mined out from within	
..... ponderosa pine needle miner, <i>Coleotechnites</i>	33
3. Needles badly distorted, shortened, bases swollen	
..... needle midges	35
4. Sucking insects, usually attached to or appearing to rest	
quietly on needles	9
..... scales	
..... aphids	9
..... cicadas	11

Damage to Trunk, Entire Tree, or Wood

	Page
1. Pink or reddish frass in bark crevices and around base of tree; pitch tubes may be present; galleries in cambial area; entire tree eventually fades	
..... bark beetles, <i>Dendroctonus</i> , <i>Ips</i> , etc.	21
2. White frass in bark crevices in basal 0.5 m of tree; no pitch tubes; fungus-stained galleries penetrate directly into wood; often associated with successful bark beetle attack; also in lumber	
..... ambrosia beetles	27
3. Large (up to golf ball size) masses of pitch on trunk (sometimes also on larger limbs)	
..... pitch moths	31
4. Large larvae, pupae, or adults in cambial area or in wood; found in dead trees, logs, or lumber; tunnels in wood, lumber	
a. Tunnels more or less flattened or oval in cross section	
..... roundheaded borers, <i>Cerambycidae</i>	13
..... flatheaded borers, <i>Buprestidae</i>	13
b. Tunnels circular in cross section	
..... horntails, <i>Siricidae</i>	38

SECTION 3

ANNOTATED LIST OF COMMON INSECT SPECIES AND GROUPS ASSOCIATED WITH PONDEROSA PINE

Grasshoppers, Crickets, and Others—Order Orthoptera

Grasshoppers are known for great changes in numbers from one year to another. During outbreaks, feeding damage to a wide variety of plants is possible, including defoliation of young ponderosa pines.

Termites—Order Isoptera

Termites are soft-bodied, fragile insects that usually shun light and are secretive in their habits. They feed on nonliving wood and cause serious damage to structures in many parts of the country. In the forest they help speed decay and decomposition of dead wood. Many species of termites occur in the warm Southwest, but only two, *Reticulitermes tibialis* Banks and *R. flavipes* (Kollar) are regularly found in the interior of our area.

Earwigs—Order Dermaptera

Earwigs are scavengers on decaying plant and animal matter. Although sometimes found beneath the bark of dead or dying pines, they do no harm to trees. A large pincer-like structure at the end of the abdomen helps identify this group.

True Bugs—Order Hemiptera

Many bugs are plant feeders (also many species are predators on other insects), and are readily seen and collected as they rest on ponderosa pine foliage and branches. They are generally good fliers and have mouthparts adapted for piercing and sucking. A few species are closely associated with the trees; many others feed on grass, herbs, and other vegetation.

Leaf-footed Bugs—Family Coreidae

One species of leaf-footed bug, *Leptoglossus occidentalis* Heidemann (fig. 1), is a large (about 15 mm long), conspicuous insect that feeds on the cones of several different conifers, including ponderosa pine. The beak is inserted through the cone scales into individual seeds, and the material within is dissolved and sucked up. A damaged seed is not readily distinguishable from a sound one; however, it will not produce a normal seedling. Under field conditions, it is doubtful that *L. occidentalis* causes enough damage to inhibit regeneration.

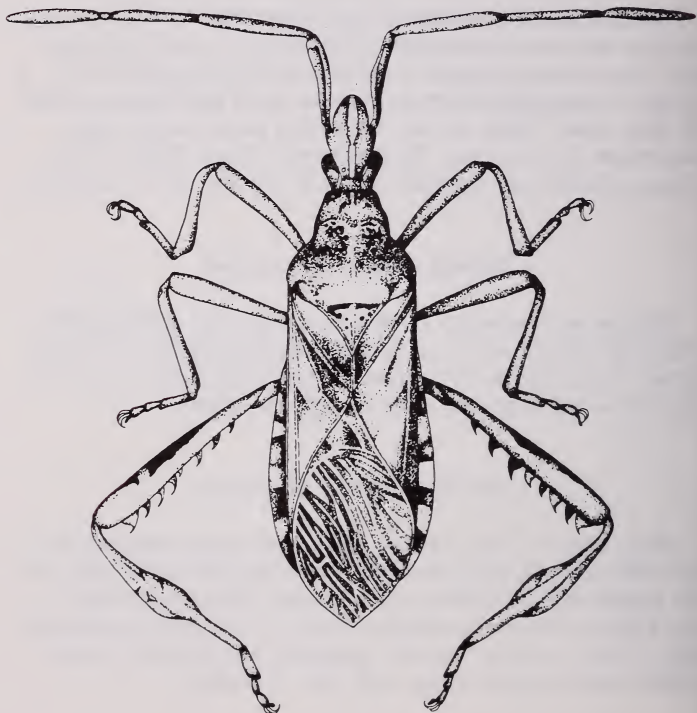


Figure 1.—*Leptoglossus occidentalis*, a seed-eating bug. Bug is about 15 mm long.

Plant Bugs—Family Miridae

Plant bugs and other small bugs are common on pines and are readily collected by beating foliage over a cloth. Mirids are small (2–9 mm), fragile, and usually inconspicuous. Most are plant feeders, although none is known to feed on conifers. Members of one genus, *Neoborella*, feed on pine dwarf mistletoe.

Aphids, Scales, and Others—Order Homoptera

Members of the Homoptera are similar to the Hemiptera in that they have four wings (at least during some developmental stage) and sucking mouthparts.

Scale insects are a common and more economically important group of Homoptera. Many species of these insects infest ponderosa pine. The pine needle scale, *Chionaspis pinifoliae* (Fitch), (fig. 2) is a common species, and the Prescott scale, *Matsucoccus vexillorum* Morrison, is occasionally a pest. Woolly aphids, genus *Pineus*, are common on succulent new shoots in early summer and produce large amounts of conspicuous silky-looking wax. Palmer (1952) provides keys and descriptions of Colorado aphids. Other genera reported include *Cinara*, *Essigella*, *Eulachnus*, and *Schizolachnus*.

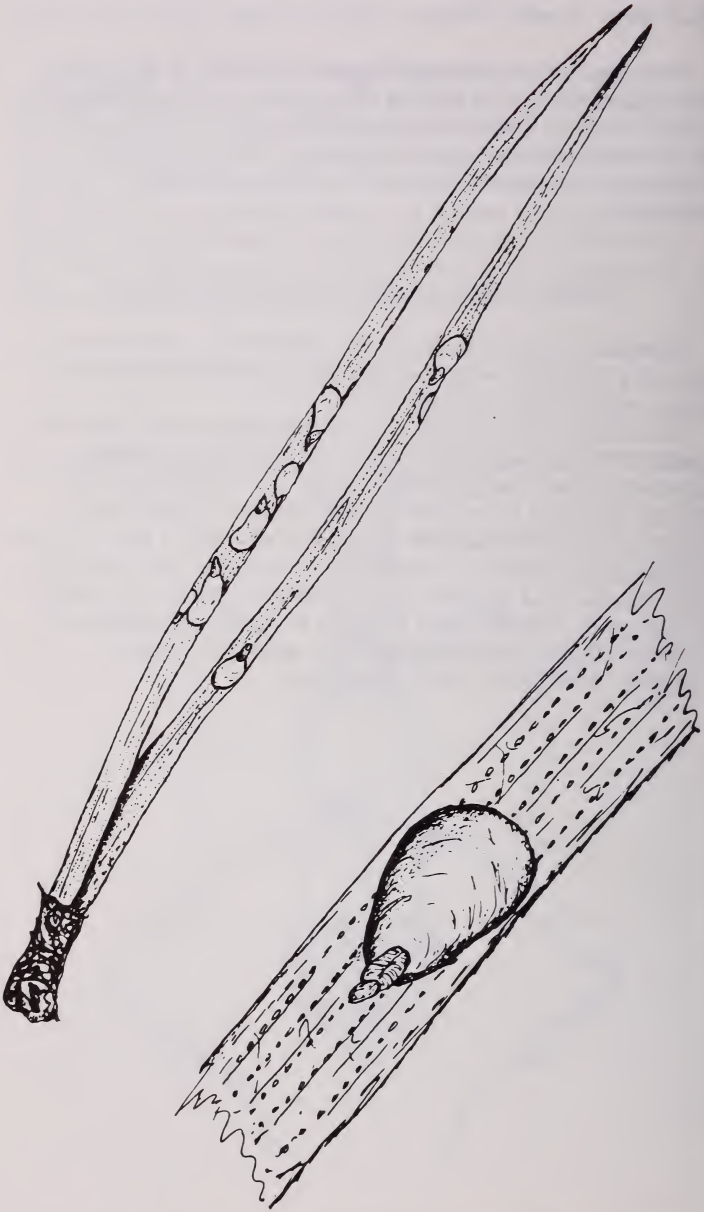


Figure 2.—Pine needle scales, 2 to 2.5 mm long.

Cicadas are a group of large Homoptera that are common in the pine forest, although the adults usually do no more than rest in pine trees. Cicada nymphs (17-year locusts, etc.) live from several to many years in the soil, feeding on roots. Adults (fig. 3) lay eggs in branches and shoots of many kinds of trees and shrubs, sometimes causing considerable shoot breakage.



Figure 3.—Adult cicada resting on twig. Insect is 20-25 mm long.

Lacewings and Snakeflies—Order Neuroptera

Many members of this order are predators of pest insects in both immature and adult stages and are considered beneficial. Lacewings (fig. 4a), are light green or brown. Adult snakeflies (fig. 4b), as their name indicates, resemble serpents. Both groups have large but delicate wings. Aphids and butterfly or moth larvae are common prey.

Along with other natural enemies, insect predators and parasites are often important in holding populations of pest insects under control. Sometimes this "balance of nature" gets upset, and one or another kind of insect will reach high population levels. High population levels of pest insects are called "outbreaks," or "epidemics."

In some instances, natural enemies can be favored, or even manipulated. This is "applied biological control," a desirable approach to keeping insect pests below damaging levels.



Figure 4.—Adults of (a) lacewing and (b) snakefly. Insects are in 15 mm long.

Beetles and Weevils—Order Coleoptera

Beetles are possibly the most numerous and most destructive group of insects associated with ponderosa pine. The bark beetles, family Scolytidae, are important tree-killers. Larvae of roundheaded and flatheaded borers, families Cerambycidae and Buprestidae, commonly colonize recently killed trees, feeding in the cambial area and often later tunneling into the wood. Larvae of weevils, family Curculionidae, infest cones and root collars of dying trees, and adults often feed on pine foliage.

Flatheaded Borers, Metallic Wood Borers—Family Buprestidae Longhorned Beetles, Roundheaded Wood Borers, Sawyers— Family Cerambycidae

Insects belonging to these two families (figs. 5 and 6) have similar ecological roles with respect to ponderosa pine, and tree-infesting species have similar life cycles and habits. Adult females of both families lay eggs in niches in the bark of dying or recently killed trees. Larvae tunnel in the cambial area and may subsequently move into the wood. Larval galleries make irregular patterns and become larger as the insects grow. Buprestid larvae have a typical “horseshoe nail” shape; cerambycid larvae are less flattened. Life cycles may extend over several years. Buprestids and cerambycids are often responsible for chewing noises heard coming from infested pine firewood. Borer adults occasionally emerge in houses from studs sawed from fire-killed timber that was infested while still in the woods, or from logs used in rustic cabins. Larval galleries are packed with frass and wood shavings; emergence tunnels and holes in the bark through which the adults exit the tree are open, round or oval in cross section, and up to 5 mm in diameter. Important genera of these two families include *Monochamus*, *Canonura* (= *Acanthocinus*), *Ergates*, *Asemum*, and *Tragosoma* (Cerambycidae); and *Chalcophora*, *Dicera*, *Buprestis*, and *Melanophila* (Buprestidae).

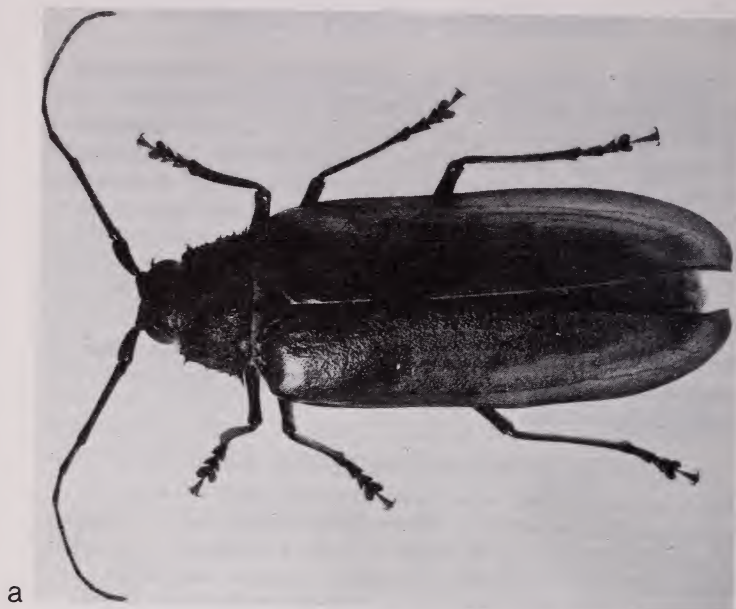
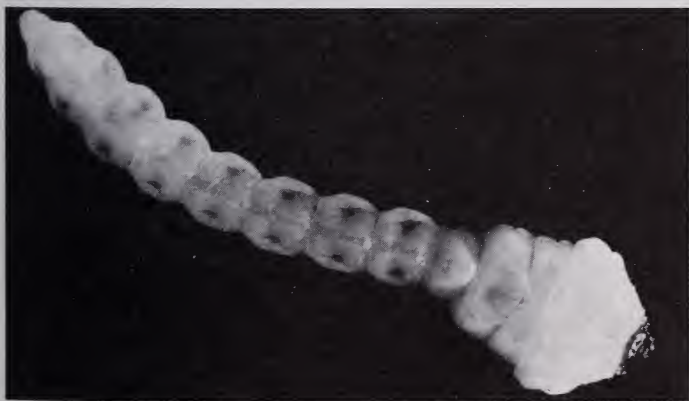


Figure 5.—Longhorned beetle (a) adult, 55 mm long; and (b) larva, 60 mm long, removed from feeding tunnel in wood.



a



b

Figure 6.—Metallic wood borer (a) adult, 20 mm long, and (b) horse-shoe-nail-shaped larva, 25 mm long.

Weevils—Family Curculionidae

Weevils, or “snout beetles” (some actually have very short “snouts”), are a large and highly variable group of beetles with an equally wide variety of habits. Many species are found in and on trees, but only four genera are important to us here:

Scythropus.—Weevils of this genus are often responsible for “saw-tooth” feeding seen on pine needles (fig. 7). The adults are somewhat elongate, broad-nosed weevils ranging from 4.5 to 7.5 mm in length. Some species are colorful, ranging from the ashy-white of *S. albidus* Fall to the bronze of *S. californicus* Horn to the metallic blue green or gold of *S. elegans* (Couper). These weevils feed on old needles in the spring and early summer. These insects may be minor pests in ornamental plantings but do not cause economic damage in forest situations.

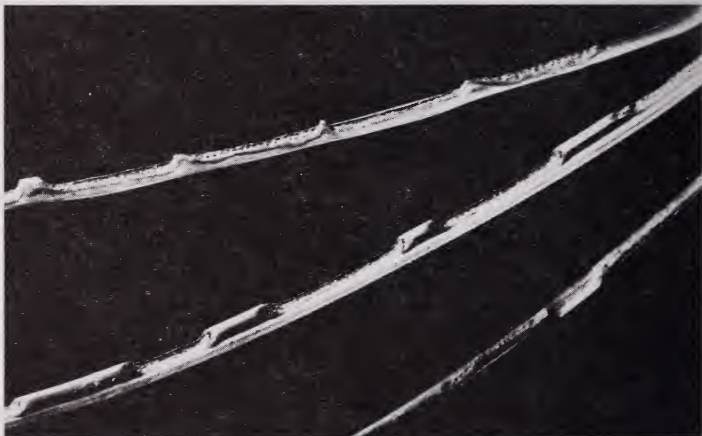


Figure 7.—Pine needles fed on by *Scythropus* beetles.

Pissodes schwarzi Hopkins.—Found in rare instances infesting the root-collar area of small (< 2 m tall) trees. As a general rule, *P. schwarzi* is not successful in attacking healthy trees, but succeeds only in hosts weakened by some other factor. This and other *Pissodes* weevils pupate in characteristic “chip cocoons” (fig. 8). Entomologists refer to species such as this as “secondary,” as opposed to “primary,” pests. Primary pests colonize apparently healthy hosts. For example, most defoliators are considered “primary,” because the condition of the host tree is not thought to have much to do with whether or not the tree is successfully attacked by the insects. “Secondary” species, such as these weevils, generally do not attack healthy, vigorous trees. Other typically secondary insects include wood boring beetles, turpentine beetles, ips beetles, ambrosia beetles, and horntail wasps.



Figure 8.—*Pissodes* (a) larva, 4.5 mm long; and (b) “chip cocoons”.

Conotrachelus neomexicanus Fall.—This weevil, known as the “ponderosa pine cone weevil,” (fig. 9) has recently been identified as a cone pest. Larvae mine indiscriminately within the cone, reducing its interior to fine sawdust-like frass. Larvae drop to the ground in midsummer, pupate in cells in the soil, emerge in fall to feed on needles and shoots, and overwinter in the adult stage.

Magdalis.—Weevils of this genus develop in twigs and branches. The adults, often colored black, bright metallic blue, or green, are sometimes found on ponderosa pine shoots and foliage. *M. lecontei* Horn is a common species infesting ponderosa pine.

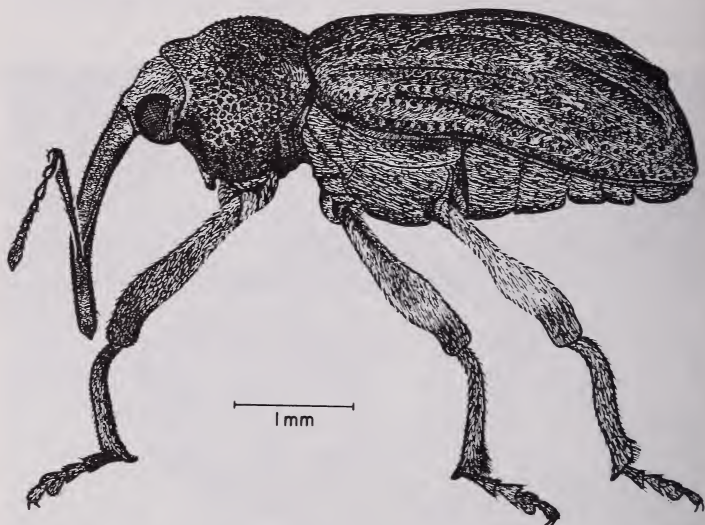


Figure 9.—Adult ponderosa pine cone weevil.

Checkered Beetles or Clerids—Family Cleridae

Several species of clerids (fig. 10) are important bark beetle predators. Clerid larvae operate in the bark beetles' galleries, and adults capture bark beetle adults on the bark surface. Following are the most important species:

Enoclerus sphegeus (Fabricius)—red-bellied clerid

E. lecontei (Wolcott)—black-bellied clerid

Thanasimus dubius Fabricius

T. undatulus (Say)

Darkling Beetles—Family Tenebrionidae

Beetles of this family, highly varied in appearance, are commonly found under the bark in decaying wood of trees killed by bark beetles. Tenebrionids are mostly scavengers. The ones seen most often are small, slender, shiny, dark-red-colored beetles.

Trogositid Beetles—Family Trogositidae (= Ostomidae)

Temnochila chlorodia (Mannerheim), a metallic bluish-green trogositid beetle, is a common bark beetle predator.

Cylindrical Bark Beetles—Family Colydiidae

Although they are common in bark beetle-infested trees, little is known of the precise role(s) these small brown insects play in pines. Members of the genus *Aulonium* inhabit mountain pine beetle galleries, occasionally in large numbers. Some species are said to be predaceous; others scavenge organic matter.

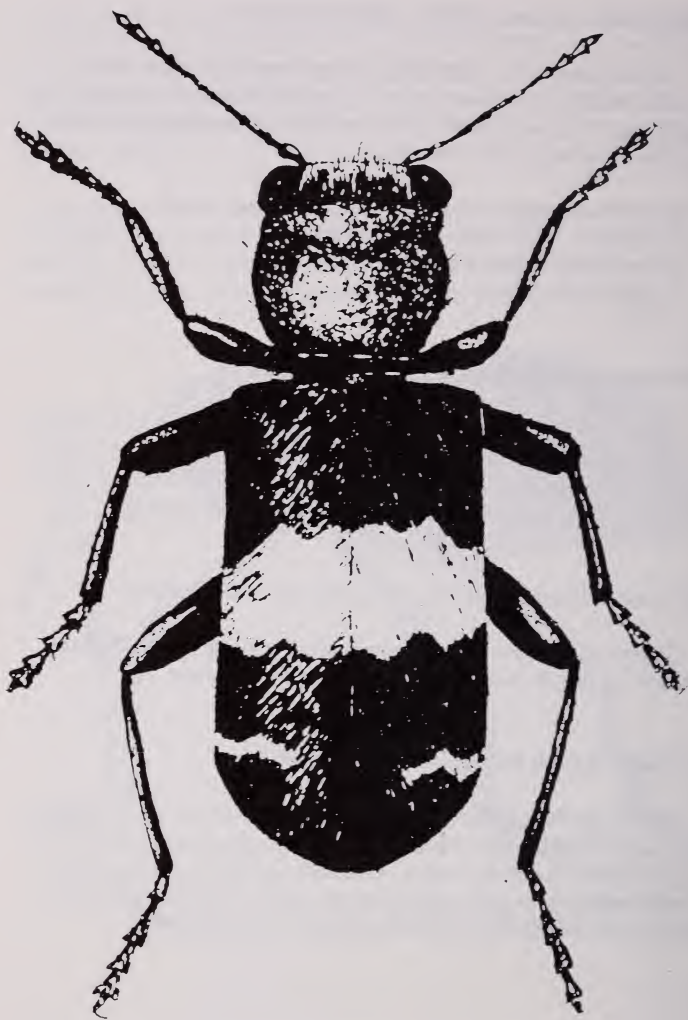


Figure 10.—Adult clerid beetle, about 10 mm long.

Bark Beetles—Family Scolytidae

Bark beetles, especially those in the genus *Dendroctonus*, are one of the most destructive groups of forest insects in western North America. Adults of most genera bore through the bark to lay eggs in galleries (fig. 11) in the cambial area. Larvae generally mine in the same area. Their feeding galleries, in addition to the egg galleries made by the adults, create a lasting pattern of “tracks” on the surface of the wood by which the species can be identified even long after the insects themselves have disappeared.

All the bark beetles carry spores of “blue stain” fungi. These spores, introduced into “beetle trees” when the beetles attack, multiply and effectively block the trees’ water and nutrient conducting systems. Thus, in a “successfully” attacked tree, the beetles and the blue stain fungi combine forces to kill the tree.

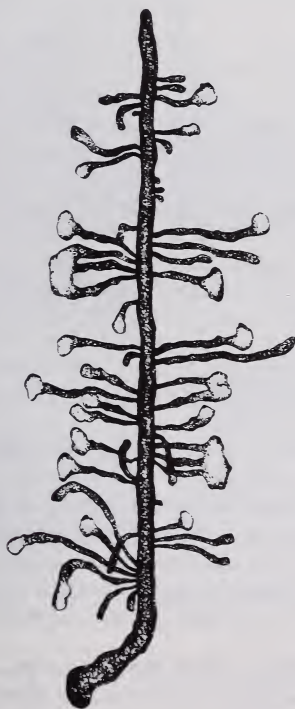


Figure 11.—Mountain pine beetle gallery system; entrance hole at bottom, vertical egg gallery, and horizontal larval galleries. Egg gallery may be up to 80 cm long.

Mountain pine beetle, *Dendroctonus ponderosae*

Hopkins.—This species is a serious enemy of ponderosa pine, particularly in South Dakota, Wyoming, Colorado, and the Kaibab Plateau of northern Arizona. During outbreaks, it can kill thousands of healthy appearing trees annually. In late summer (August, generally), adult beetles bore through the bark and into the cambium area of living trees, mate, and then lay eggs in vertically oriented egg galleries. The eggs (fig. 12a) hatch in a few days and the tiny larvae (fig. 12b) begin feeding outward from the egg gallery, still in the region of the cambium. Pupae (fig. 12c) and adults (fig. 12d) develop at the ends of the larval galleries. Flight and egg laying occur generally during late July and August. Successfully attacked trees, although remaining green until the following summer, are in fact killed within just a few days. The beetle progeny mostly overwinter as small larvae, completing their development and emerging from host trees to renew the cycle the following summer.

Efforts to minimize tree losses caused by bark beetles include killing beetles in infested trees before they are able to emerge to attack green living trees, spraying of individual living high-value trees to prevent beetle attack, and thinning to change conditions in forests that are susceptible to beetle outbreaks.

Western pine beetle, *D. brevicomis* LeConte.—This species is a major pest on the West Coast, sometimes causes problems in Arizona and New Mexico, and is rare in southwestern Colorado. It has distinctive meandering egg galleries, as opposed to the vertically oriented ones of *D. ponderosae*. The larvae, instead of remaining in the cambial area, do most of their mining in the inner and outer bark. Pupation is in the outer bark. Western pine beetle has several (usually around three) annual generations.

Roundheaded pine beetle, *D. adjunctus* Hopkins.—This is a southern species extending from the southwestern U.S. into Mexico and Central America. It is found as far north as southwestern Colorado and has occasionally been a serious tree-killer in unmanaged second-growth ponderosa pine stands in New Mexico. It is often found colonizing trees in conjunction with other *Dendroctonus* species.

Southern pine beetle, *D. frontalis* Zimmerman.—This species, a major pest in the southeastern States and in Mexico and Central America, is also known from southern Arizona and New Mexico. Its life history and habits are similar to those of western pine beetle.

Larger Mexican pine beetle, *D. approximatus* Dietz.—Beetles of this species inhabit pine and spruce in the southern Rockies. It is not aggressive and favors the lower trunk of large-diameter trees already overcome by other bark beetle species. Its egg galleries typically wind and cross each other. The larval mines are wholly within the outer bark.

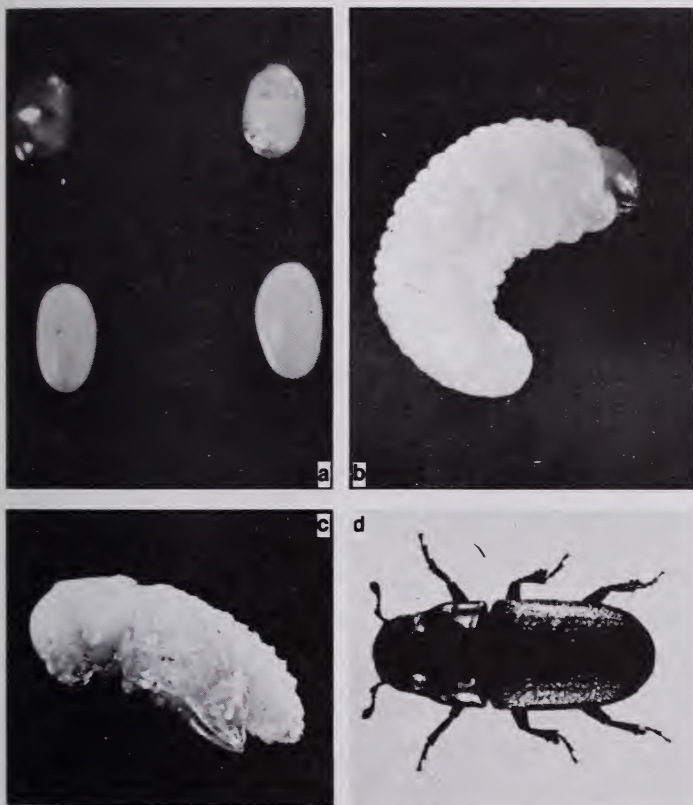


Figure 12.—Bark beetle life stages a. eggs, 1 mm long; b. larva, up to 8 mm long; c. pupa, d. adult, up to 7.5 mm long.

Red turpentine beetle, *D. valens* Le Conte.—While sometimes attacking otherwise healthy trees, this beetle is usually found in the basal (up to about 0.5 m) portion of damaged trees or trees infested with other species of *Dendroctonus*. Turpentine beetles are not usually tree-killers by themselves, but can weaken trees and make them more susceptible to attack by other, more aggressive bark beetles. Turpentine beetles have a tendency to attack trees that have been injured by fire, during logging, road or building construction, and similar kinds of activities. Stumps are also colonized. Large pitch tubes (fig. 13) are characteristic of attacks by this species.



Figure 13.—Pitch tubes at base of tree resulting from attack of red turpentine beetle.

Ips bark beetles; pine engraver beetles, *Ips* spp.—Ips beetles (fig. 14) are common in pine forests. Their name is unusual in that it is both a common and a scientific name. Ips are often secondary and colonize the upper parts of trees killed by *Dendroctonus* bark beetles. They commonly infest slash, creating piles of frass in bark crevices. Also, fire-scorched trees are often susceptible to ips attacks and may, like slash, trigger short-lived outbreaks in standing healthy trees. *Ips* egg galleries (fig. 14a) are readily distinguished from those of *Dendroctonus*, as they are kept free of frass. Adult beetles are also easily separated from *Dendroctonus* by their concave posterior “declivity” (fig. 14b). Important species in ponderosa pine include:

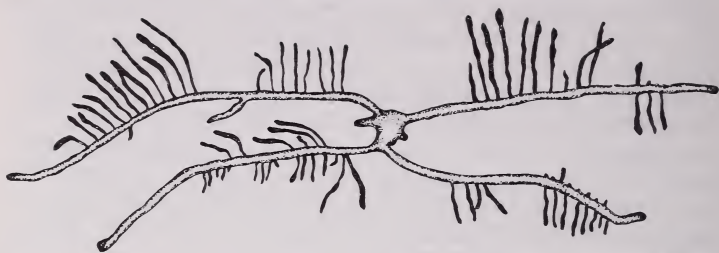
Ips calligraphus (Germar)

I. integer (Eichhoff)

I. knausi Swaine

I. lecontei Swaine

I. pini (Say)



a



b

Figure 14.—Ips beetles (a) gallery system as in a down log, and (b) concave spined declivity of adult. Note central “nuptial chamber” and radiating egg galleries. In a standing tree, gallery is oriented vertically, and may be up to 25 cm long.

***Hylurgops* spp.**—Adults strongly resemble *Dendroctonus*, but have noticeably rougher, less shiny bodies, and are substantially smaller. *H. subcostulatus* (Mannerheim) is known from ponderosa pine. It is also secondary (i.e., not a tree-killer) and is typically found in the basal portions of trees killed by *Dendroctonus*. Early spring-emerging *Hylurgops* beetles are often mistaken for mountain pine beetles.

Twig beetles.—Several genera of small (about 2 mm long) bark beetles sometimes infest ponderosa pine twigs and branches, causing them to flag (i.e., fade). This results in some of the natural pruning that goes on continually in the forest. Usually the infestation proceeds at low level and is inconspicuous; but, at times, high beetle populations develop, and the fading attracts attention. On rare occasions, trunks of small ponderosa pine saplings that are growing poorly can be invaded. Genera involved include *Pityophthorus*, *Pityogenes*, and *Carphoborus*.

Ambrosia beetles.—Ambrosia beetles are a group of bark beetles that bore directly through the bark into the wood, generally in dead or dying trees. Often they follow closely after *Dendroctonus* beetles, colonizing the basal portion of trees killed by the mountain pine beetle, attacking the following summer. The feeding habit of ambrosia beetles is different from other scolytid beetles; the larvae develop in short galleries, or "cradles," (fig. 15) prepared by the adults well within the sapwood. They feed on fungi that colonize the walls of the "cradles." The pinholes and associated stain caused by ambrosia beetles can result in downgrading of otherwise good quality lumber. Several species of the genus *Gnathotrichus* are known from ponderosa pine.

Ponderosa pine cone beetle, *Conophthorus ponderosae* Hopkins.—This small bark beetle is a common enemy of second-year cones. Adults bore into the base of the cone; the cone never reaches normal size and produces no seed. All beetle development takes place within the cone.



Figure 15.—Ambrosia beetles in “cradles” in wood.

Moths and Butterflies—Order Lepidoptera

Many species of moths and butterflies are closely associated with conifers, and some are destructive pests in the larval or caterpillar stage. The more important groups that feed on ponderosa pine are as follows:

Whites and Sulphurs—Family Pieridae

This family includes a number of destructive agricultural pests. One species, the pine butterfly, *Neophasia menapia* (Felder and Felder), is common throughout western ponderosa pine forests. The medium-sized, mostly white adults are often seen in the summer flitting about the tree tops. The larvae, less commonly seen, are smooth-bodied and are marked with green with white stripes. Populations usually are maintained at low levels but can increase to outbreak proportions and cause considerable damage.

Giant Silkworm Moths—Family Saturniidae

Pandora moth, *Coloradia* spp.—This genus contains two species, *C. pandora* Blake, and *C. doris* Barnes, known to injure ponderosa pine. Larvae of both these species feed on old needles, gregariously at first and individually when mature. Full-grown larvae are large, up to 80 mm long, and usually light yellow-green or gray-green. They have a white stripe running down the center of the back and short, stout black spines on each body segment. Pupation is in the soil. The thick-bodied adults are dark gray with yellow antennae and often bright pink hairs on the hind wing bases and interior margins. The life cycle requires 2 years in the case of *C. pandora*, 1 year for *C. doris*.

Tiger Moths—Family Arctiidae

Larvae of several species of tiger moths (genus *Halisidota*) build heavy webs (fig. 16) in terminals (and occasionally laterals) on pines and other western conifers. From these webs, the larvae move out to feed on the foliage. Little damage appears to result, but the webs are conspicuous and often attract attention. *H. ingens* Hy. Edwards, probably the most common species, overwinters in the larval stage and can be found feeding on warm winter days.



Figure 16.—*Halisidota* web and defoliation caused by feeding larvae.

Pyralid Moths—Family Pyralidae

Several species of the genus *Dioryctria* (fig. 17) infest different parts of ponderosa pine trees. *D. zimmermani* (Grote) is a serious pest of ponderosa pine in plains plantings as well as natural stands. Larval feeding in limbs and boles can result in weakened areas prone to wind breakage. Larvae of *D. cambiicola* (Dyar) and *D. baumhoferi* Heinrich work mainly in branch tips, killing the outer several centimeters and producing a conspicuous mass of pitch and frass on the outside of the twig. *D. rossi* Munroe, *D. auranticella* (Grote), and *D. abietivorella* (Grote) commonly infest ponderosa pine cones.

Pine webworms, genus *Tetralopha*, have recently been collected from ponderosa pines in the vicinity of Fort Collins, Colo. Their presence is conspicuous in late summer because of brown, frass-filled silk tents made by groups of feeding larvae. These tents occur throughout the crown at branch ends. Pupation is in the soil, with adult moths apparently emerging the following early summer to lay eggs. Webworm damage is not serious.



Figure 17.—Adult *Dioryctria* moth, wing span about 25 mm.

Leafroller Moths—Family Tortricidae

Four genera of tortricid moths are commonly found infesting ponderosa pines. Among them are several potentially serious pests of regeneration, stands being managed for high-value forest products, and/or high-value individual trees growing as ornamentals in urban situations.

***Rhyacionia* spp.**—Several species of *Rhyacionia* pine tip moths are known from ponderosa pine. These include the southwestern pine tip moth, *R. neomexicana* (Dyar), the western pine tip moth, *R. bushnelli* Busck, and *R. fumosana* Powell. All the pine tip moths infest new shoots, hollowing them out. Severe tree stunting is possible, but mortality is rare. *R. neomexicana* is a serious pest of some forest plantings and natural regeneration in Arizona, and can also be important in windbreak and Christmas tree plantings throughout the area. Fortunately, once trees grow beyond 3-4 m tall, they are no longer attacked severely. On smaller trees, though, damage can be serious.

***Petrova*.**—One species, *P. metallica* (Busck), is commonly found. These “pitch nodule moths” mine in new shoots and produce a consolidated mass of pitch at the site of entry into the shoot, like *Dioryctria cambiicola* and *D. baumhoferi*. As in the case of *Dioryctria*, the portion of the shoot beyond the pitch nodule dies, and stunting and deformation result.

***Eucosma*.**—Larvae of the western pine-shoot borer, *E. sonomana* Kearfott, are responsible for reduced height growth of ponderosa pine in certain locations. The larvae infest new terminals, but feed only in the pith; the terminal often lives, but is stunted. Laterals assume dominance; or the leader retains dominance, but is short. A characteristic “shaving brush” appearance results as shoot length is reduced and needle bundles are more closely spaced than usual. After a short feeding period, the larvae abandon the aerial portion of the tree to overwinter in silken cocoons in the soil.

***Cydia* (= *Laspeyresia*).**—This genus includes several species of “seed moths.” Distribution and relative abundance of the insects are largely unknown, as is their impact on ponderosa pine seed production.

Pine tortrix, *Choristoneura lambertiana ponderosana* Obraztsov.— This moth, a close relative of the well-known spruce budworm, is common in certain ponderosa pine areas in some years. Heavy defoliation has tended to be localized in canyons and along highways, rather than being extensive, and the tortrix is not considered a major pest. Larvae feed on new needles and can cause total loss of the current year's foliage. They chew through the needle sheath and feed on the succulent new needle tissue inside. Abundant unconsolidated webbing is produced. Damaged needles fade rapidly and most drop by winter. The insects pupate in the tips near the feeding sites. Eggs are laid in overlapping rows on the older needles, and the tiny larvae overwinter in silken hibernacula in protected locations on the tree.

Gelechiid Moths—Family Gelechiidae

This family includes a group of moths known as needle miners (fig. 18), some of which are found in pine forests. One species, the ponderosa pine needle miner, *Coleotechnites ponderosae* Hodges and Stevens, has since 1971 been recognized as a pest in certain parts of the Colorado Front Range, as well as in the Black Forest, Durango, and other Colorado areas. The insect has a 1-year life cycle, with the adults flying in August and September. Eggs hatch in mid-to-late September, and the insects overwinter inside needles in the larval stage. *C. ponderosae* prefers older foliage, and relatively few of the new, high nutrient-producing needles are damaged. Nevertheless, heavy feeding over several successive years can result in weakened trees.

Another ponderosa pine needle miner, an undescribed species of the genus *Exoteleia*, has recently been identified from west-central New Mexico and east-central Arizona. This species, while closely resembling and closely related to *C. ponderosae*, has a slightly different life cycle. It appears to prefer new foliage, and has more potential for adversely affecting host trees.



Figure 18.— Needle miner life stages, entrance and exit holes in needle, and larvae inside needles. Moth wing span about 12 mm.

Ermine Moths—Family Yponomeutidae

One species of ermine moth, *Zelleria haimbachi* Busck, is relatively common in ponderosa pine. *Z. haimbachi*, the pine needle sheath miner, feeds in the latter larval stages much like the pine tortrix, and defoliation caused by the two is superficially hard to separate, especially when they occur together, as they often do. Both pupate in masses of silk in the mined shoots; however, *Z. haimbachi* larvae overwinter within pine needles while those of the pine tortrix overwinter within hibernacula in bark crevices.

Flies and Midges—Order Diptera

A few species of Diptera, mainly in the family Cecidomyiidae, cause damage to ponderosa pine. Attacks by the gall midge *Con-tarinia coloradensis* Felt causes excessive tissue growth of the fascicles and needle base and reduced length of the needles. Galled needles (fig. 19) are globular, 6-12 mm in diameter and very short; some are so deformed as to be nearly unrecognizable. Infested needles drop from the tree at the end of the first year and thus attacks can result in conspicuous loss of foliage. Fortunately, heavy infestations seem to be highly localized, and the insects are not serious pests.

Cone midges are also found in ponderosa pine, but little is known about their habits or the damage that they cause. Larvae of *Rubsaamenia keeni* Foote are very small (3 mm) red, pink, or orange maggots found within and around cone scales and seeds. The adults are tiny, fragile flies.

Pine resin midges, also called pitch midges, are similar in appearance to cone midges but are more damaging. For example, *Cecidomyia piniinopis* Osten Sacken attacks current year's shoots of ponderosa pine, often deforming and sometimes killing them. The damaged shoots fade, droop, and eventually die. Infested tips have small, resinous pockets containing small, red maggots under the bark. If the larvae are not numerous, the tips may recover, but growth is reduced. Populations can vary greatly from year to year due to natural control factors.

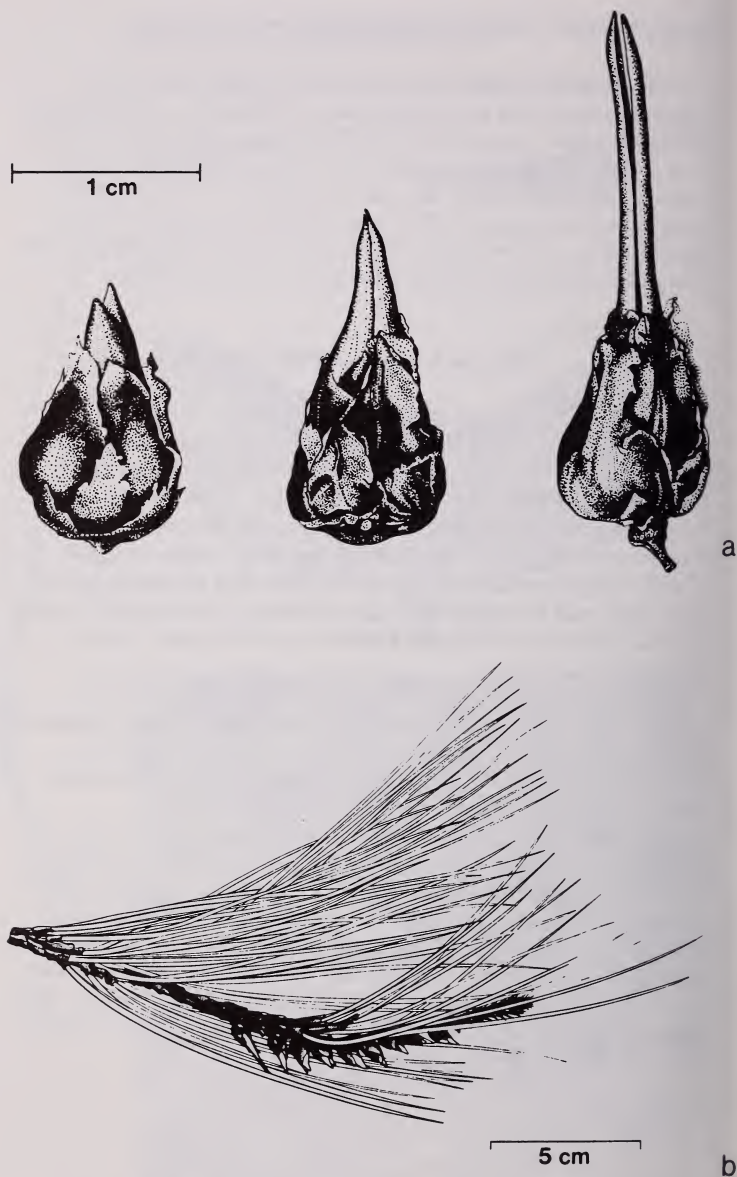


Figure 19.—Galls in ponderosa pine due to infestation by gall midges (a) shows variability; (b) shows galls in place on shoot.

Ants, Bees, Sawflies, and others—Order Hymenoptera

Conifer Sawflies—Family Diprionidae

Neodiprion fulviceps (Cresson), *N. gilletti* (Rohwer), *N. ventralis* Ross, *N. wernerii* Ross, and *Zadiprion townsendi* (Cockerell) are among species known from the area. In general, sawflies are not serious pests in the central Rocky Mountains and the Southwest. The name “sawfly” refers to the saw-like ovipositor with which females make the slits in pine needles where they deposit their eggs. Larvae of these sawflies feed on the foliage and drop to the soil to pupate in hard, capsule-like cocoons. Like many other defoliators, they may also feed on the exterior surfaces of young tender shoots. Young sawfly larvae feed in clusters on individual needles (fig. 20). No webbing is produced. The larvae have shiny heads and a distinctive habit of rearing back from their feeding position when disturbed. Each species overwinters in one of three life stages: egg, larva, or pupa. Most overwinter as eggs or pupae, but *Z. townsendi* overwinters on the foliage in the larval stage.



Figure 20.—Young sawfly larvae, about 18 mm long, clustered characteristically on pine needles.

Horntail Wasps—Family Siricidae

Horntail wasp larvae occupy ecological niches similar to those of the wood-boring beetles, Buprestidae and Cerambycidae. They tunnel in the sapwood of damaged, dying, or recently killed trees, including ones killed by forest fires. *Sirex*, *Xeris*, and *Urocerus* are common genera. The name "horntail" refers to the dangerous-looking ovipositor on the adult female and also to a posterior projection on the larvae.

Webspinning Sawflies—Family Pamphiliidae

The genus *Acantholyda* contains at least two species (*A. verticalis* (Cresson) and *A. brunnicans* (Norton)) known from area ponderosa pine. Larvae of *A. verticalis* feed solitarily on new growth and often shroud the terminal bud area with webbing and frass pellets. Mature larvae are large for sawflies with longitudinal striping. Pupation is apparently in the soil. The adults are also large (> 20 mm).

Ants—Family Formicidae

Ants are commonly found in and around pine trees. They have no direct effect on living trees, but presence of ants often indicates the presence of aphids, from which the ants obtain honeydew. In some cases, protection afforded aphids by ants may favor aphid population increases. Several species of ants commonly obtain nectar from ponderosa pine dwarf mistletoe and, in the process, pollinate dwarf mistletoe flowers. Carpenter ants, large black species, often tunnel extensively in down and decaying wood and sometimes colonize unfinished wood in cabins and other structures.

**Braconids, Chalcids, and Ichneumons—Families
Braconidae, Chalcididae, and Ichneumonidae**

Many insect species in these families are parasites of other—sometimes harmful—insects (fig. 21). One genus of chalcids, *Megastigmus*, includes several species that colonize conifer seeds and can be pests. *M. albifrons* Walker occurs throughout the West.



Figure 21.—Parasitic wasp, *Glypta* sp., laying egg in body of concealed host larva. Wasp is about 10 mm long.

SECTION 4

REFERENCES

- Brewer, J. Wayne, and Peter R. Johnson. 1977. Biology and parasitoids of *Contarinia coloradensis* Felt, a gall midge on ponderosa pine. *Marcellia* 39:391-398.
- Bodenham, Judy, Robert E. Stevens, and T. O. Thatcher. 1976. A cone weevil, *Conotrachelus neomexicanus*, on ponderosa pine in Colorado: Life history, habits, ecological relationships (Coleoptera:Curculionidae). *Canadian Entomologist* 108:693-699.
- Bodenham, Judy, and Robert R. Stevens. 1981. Insects associated with second-year ponderosa pine cones, Larimer and Boulder Counties, Colorado. *The Southwestern Naturalist* 26(4):375-378.
- Borror, Donald J., Dwight M. Delong, and Charles A. Triplehorn. 1981. An introduction to the study of insects. Fifth edition. 827 p. Holt, Rinehart, and Winston, New York, N.Y.
- Borror, Donald J., and Richard E. White. 1970. A field guide to the insects of America north of Mexico. The Peterson Field Guide Series, Field Guide 19. 404 p. Houghton Mifflin Co., Boston, Mass.
- Chansler, John F. 1967. Biology and life history of *Dendroctonus adjunctus* (Coleoptera:Scolytidae). *Annals of the Entomological Society of America* 60(4):760-767.
- Essig, E. O. 1958. Insects and mites of western North America (revised). 1,050 p. The Macmillan Co., New York, N.Y.
- Furniss, R. L., and V. M. Carolin. 1977. Western forest insects. USDA Forest Service Miscellaneous Publication 1339, 654 p. Washington, D.C.
- Hedlin, Alan F., Harry O. Yates, III, David Cibrian Tovar, Bernard H. Ebel, Thomas W. Koerber, and Edward P. Merkel. 1980. Cone and seed insects of North American conifers. 122 p. Canadian Forestry Service, USDA Forest Service, and Secretaria de Agricultura y Recursos Hidraulicos, Mexico, in cooperation with North American Forestry Commission, FAO.
- Jennings, Daniel T. 1975. Life history and habits of the southwestern pine tip moth, *Rhyacionia neomexicana* (Dyar) (Lepidoptera:Olethreutidae). *Annals of the Entomological Society of America* 68(3):597-606.
- Kinzer, H. G., B. J. Ridgill, and J. G. Watts. 1972. Seed and cone insects of ponderosa pine. New Mexico State University Agricultural Experiment Station Bulletin 594. 36 p. Las Cruces, N. Mex.

- Koerber, Thomas W. 1963. *Leptoglossus occidentalis* (Hemiptera, Coreidae), a newly discovered pest of coniferous seed. *Annals of the Entomological Society of America* 56(2):229-234.
- McCambridge, William F., Gene D. Amman, and Galen C. Trosle. 1979. The mountain pine beetle. U.S. Department of Agriculture, Forest Insect and Disease Leaflet 2, 7 p. Washington, D.C.
- Palmer, Miriam A. 1952. Aphids of the Rocky Mountain region, Volume 5. 452 p. Thomas Say Foundation. The A. B. Hirschfeld Press, Denver, Colo.
- Powell, Jerry A., and William E. Miller. 1978. Nearctic pine tip moths of the genus *Rhyacionia*: Biosystematic review (Lepidoptera: Tortricidae, Olethreutinae). U.S. Department of Agriculture, Agriculture Handbook 514, 51 p. Washington, D.C.
- Sartwell, Charles, and Robert E. Stevens. 1975. Mountain pine beetle in ponderosa pine, prospects for silvicultural control in second-growth stands. *Journal of Forestry* 73(3):136-140.
- Smith, David R. 1974. Conifer sawflies, Diprionidae: Key to North American genera, checklist of world species, and new species from Mexico (Hymenoptera). *Proceedings of the Entomological Society of Washington* 76(4):409-418.
- Stevens, Robert E., and Wayne Brewer. 1977. Pine tip moths—characteristics and control. Colorado State University Extension Service, Service in Action Leaflet 5.529, 2 p. Fort Collins, Colo.
- Stevens, Robert E., and Daniel T. Jennings. 1977. Western pine-shoot borer: A threat to intensive management of ponderosa pine in the Rocky Mountain area and Southwest. USDA Forest Service General Technical Report RM-45, 8 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.
- Stevens, Robert E., Thomas K. Borg, and T. O. Thatcher. 1977. Notes on a pine-feeding budworm, *Choristoneura lambertiana ponderosana* (Lepidoptera: Tortricidae) in the Colorado Rockies. *Canadian Entomologist* 109:1269-1274.
- Stevens, R. E., W. F. McCambridge, and C. B. Edminster. 1980. Risk rating for mountain pine beetle in Black Hills ponderosa pine. USDA Forest Service Research Note RM-385, 2 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.
- Weesner, Frances M. 1965. The termites of the United States, a handbook. 67 p. The National Pest Control Association. Elizabeth, N.J.
- Wood, Stephen L. 1963. A revision of the bark beetle genus *Dendroctonus* Erichson (Coleoptera: Scolytidae). *Great Basin Naturalist* 23(1-2):1-117.

SECTION 5

GLOSSARY

- Antennae** (sing. antenna): The pair of jointed sensory appendages on the insect head, commonly called feelers.
- Beak:** The protruding mouthparts of certain kinds of insects (e.g., aphids and cicadas) through which the insect feeds.
- Beating:** A method of collecting insects in which foliage or branches are beaten over a cloth onto which the insects drop.
- Blue stain:** Discoloration in wood caused by fungi, usually genus *Ceratocystis*, which are carried by bark beetles.
- Cambium:** In a tree, the growing part between the inner bark and the wood. **Cambial:** Pertaining to the area of the cambium.
- Chambial:** Pertaining to the area of cambium.
- Chalcid:** A small (1- to 3-mm long), heavy-bodied wasp belonging to the family Chalcididae.
- Cone:** The female reproductive structure of a conifer; the part that bears the seeds.
- Cone scales:** The woody (in pines) individual elements of a cone attached to the central core.
- Conifer:** A member of the group of cone-bearing trees; trees that generally have persistent needles.
- Crown:** The part of the tree having branches and foliage; the upper part.
- Declivity:** In bark beetles, the sloping upper rear portion of the abdomen.
- Defoliator:** An insect that chews foliage from trees.
- Dominance:** In conifers, the tendency of the topmost shoot to remain the tallest as the tree grows.
- Dwarf mistletoe:** A fleshy parasitic plant that grows on conifers.
- Fading:** Yellowing or otherwise abnormal discoloration of foliage, often resulting from insect activity.
- Fascicle:** In conifers, particularly pines, an individual bundle of needles.
- Flag:** To fade.
- Flagging:** A conspicuous clump of fading foliage; dead needles, usually on the ends of branches.
- Frass:** The mixture of feces and sawdust left behind by many chewing insects.
- Gall:** An abnormal growth of plant tissues, normally stimulated by some outside factor, often insects or mites.
- Gallery:** A series of chambers and/or tunnels in which insects, particularly bark and ambrosia beetles, live. Each species has its particular kind of gallery, and can often be identified by it.

Habitat: the place where an insect lives.

Hibernaculum (pl. hibernacula): A tiny shelter constructed of silk or some other material in which an insect (usually a larva) overwinters or hibernates.

Honeydew: A sugary excretion produced by aphids and other sucking insects.

Host: The plant (or animal) on which an insect feeds.

Lateral: On a pine tree—a more or less horizontal limb or branch, as opposed to the leader, or topmost tip of the tree.

Maggot: Legless, worm-like fly larva (Diptera).

Midge: A small, fragile fly, often resembling a mosquito.

Mine: To bore or dig beneath the surface (e.g., the activity of certain kinds of insects); also the hollowed-out area resulting from mining.

Needle sheath: On pines, the fibrous wrapping of the needle bundle that helps hold the bases of the needles together.

Niche: What the insect does; the role it plays in the environment.

Overwinter: In the case of insects, to pass the winter, often in an inactive developmental stage.

Oviposit: To lay eggs.

Ovipositor: In female insects, the structure with which the eggs are placed.

Pith: In twigs of trees and shrubs, the more porous, central part.

Population dynamics: How populations change in number of individuals from generation to generation.

Predator: An organism that feeds, usually externally, on another.

Regeneration: In forestry, this generally refers to young seedling or sapling trees.

Root collar: The part of the stem of a tree just below the surface of the ground.

Scale, scale insect: One of a group of sucking insects that become fixed at feeding locations, covering themselves individually with a more or less hard, protective coating.

Slash: Branches, treetops; generally parts of trees left in the woods after logging.

Stage: In insects, any of the development periods (e.g., larval stage).

Terminal (syn. leader): The topmost shoot of the main stem of a tree.

Acknowledgments

The authors thank Larry Helburg, Steve Krieg, and Mike Schomaker, Colorado State Forest Service, Fort Collins, who contributed original photographs. In addition, Bob Olson and Sandra Thomas, through their Colorado State Forest Service publication, "Some Common Occupants of the Ponderosa Pine," provided an inspiration for this booklet. Finally, several of the authors' colleagues made helpful comments.

Stevens, Robert E., J. Wayne Brewer, and David A. Leatherman. 1982. Insects associated with ponderosa pine in the Rocky Mountains and the Southwest. USDA Forest Service General Technical Report RM-94, 44 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Ponderosa pine serves as a host for a wide variety of insects. Many of these, including all the particularly destructive ones in the area, are discussed in this booklet. Included are a key to the major insect groups, an annotated list of the major groups, a glossary, and a list of references. This report supersedes USDA Forest Service General Technical Report RM-75.

Keywords: *Pinus ponderosa*



Rocky
Mountains



Southwest



Great
Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Bottineau, North Dakota
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Lubbock, Texas
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526